(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 211 027 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.07.2010 Bulletin 2010/30

(51) Int Cl.:
F01D 25/28 *(2006.01)* ***F01D 5/00*** *(2006.01)*

(21) Application number: **09179057.6**

(22) Date of filing: **14.12.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **31.12.2008 US 141851 P**
09.02.2009 US 367830

(71) Applicant: **General Electric Company**
Schenectady, NY 12345 (US)

(72) Inventors:
- **Kalmar, Paul L.**
  Zirconia, NC 28790 (US)
- **Sherlock, Graham David**
  Greenville, SC 29615 (US)
- **Nimmons, Francis E.**
  Fayetteville, OH 45118 (US)
- **Mays, J. David**
  Hamilton, OH 45011 (US)

(74) Representative: **Gray, Thomas**
GE International Inc.
Global Patent Operation - Europe
15 John Adam Street
London WC2N 6LU (GB)

(54) Apparatus and method for removing compressor blades

(57) An apparatus and method are provided for removing a blade (305) from a dovetailed slot in a wheel (215) of a rotating machine. At least one device (220) is adapted to apply a pushing force on a first surface of a blade. A turntable (210) for supporting the wheel has indexing capability to advance the wheel by a predetermined amount. The device can be used to remove one or more blades from the wheel.

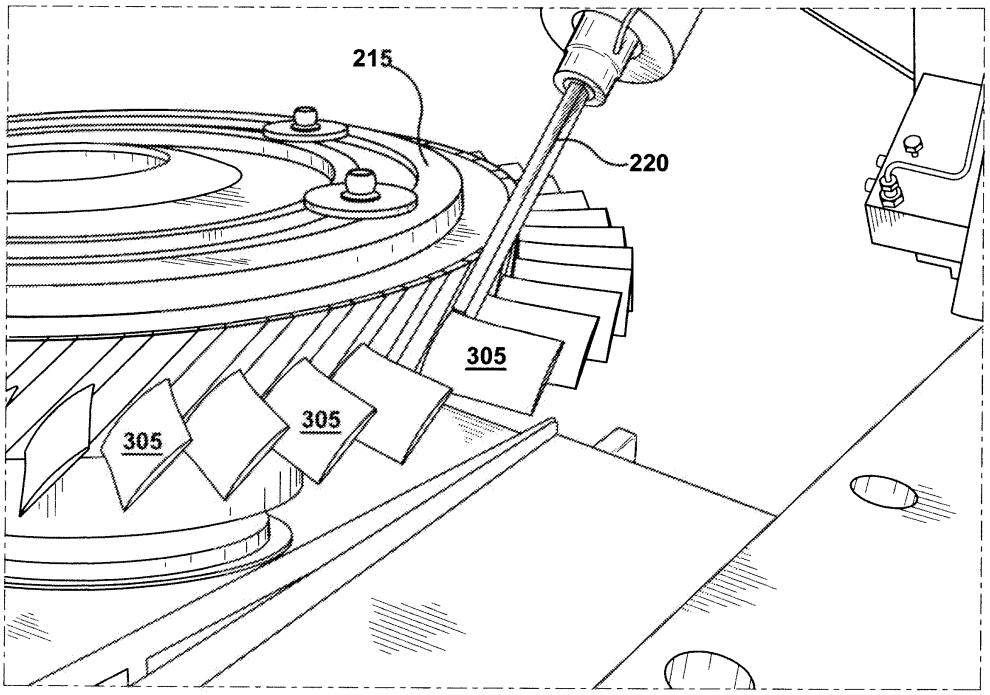


Fig.3

EP 2 211 027 A1

Description

BACKGROUND OF THE INVENTION

[0001] The invention relates generally to a compressor and more specifically to an apparatus and method for removing compressor blades.

[0002] A conventional gas turbine generally operates on the principle of compressing air within a compressor and then delivering the compressed air to a combustion chamber where fuel is added to the air and ignited. Afterwards, the resulting combustion mixture is delivered to the turbine section of the gas turbine where a portion of the energy, generated by the combustion process, is extracted by a turbine to drive the compressor via a shaft.

[0003] In multi-stage compressor sections, stators are placed at the entrance and exit of the compressor section, as well as between each compressor stage, for purposes of properly directing the airflow to each successive compressor stage. As a result, stators are able to enhance compressor performance by appropriately influencing airflow and pressure within the compressor section.

[0004] Stators generally consist of an annular array of airfoils or vanes. Stators are typically formed in segments as stator vane segments consisting of one or more airfoils supported by the base. The base includes a dovetail to maintain the stator vane unit within the casing. These stator vane segments are individually mounted to the compressor casing to form an annular array, so that the airfoils project radially between an adjacent pair of compressor stages. A rotor with blades occupies the space between the stator vanes. The rotor blades or airfoils are also connected to the rotor wheel via dovetail connection.

[0005] After prolonged use, the blades or airfoils of the compressor may need to be repaired or replaced. Some known methods for removing compressor blades from compressor wheels have relied on manual labor. In one method, a first person rests a V-shaped block mounted on the end of a long handle on the leading edge of a blade. A second person then swings a heavy sledgehammer and hits the back of the V-shaped block. This is repeated multiple times until the blade is removed from the wheel. This process is then repeated for the rest of the blades, and is a time consuming and may be a potentially hazardous activity. Another known method uses a handheld pneumatic jack-hammer to bear on the blade until it is removed. This requires significant physical effort on the part of the jack-hammer operator and may also carry risk of injury.

BRIEF DESCRIPTION OF THE INVENTION

[0006] Briefly in accordance with one aspect of the present invention, an apparatus is provided for removing a blade from a dovetailed slot in a wheel of a rotating machine. At least one device is adapted to apply a pushing force on a first surface of a blade. A turntable for supporting the wheel has indexing capability to advance the wheel by a predetermined amount. The device can be used to remove one or more blades from the wheel.

[0007] In another aspect of the present invention, a method is for removing a blade from a dovetailed slot in a wheel of a rotating machine. At least one device is provided to apply a pushing force on a first surface of a blade. A turntable is provided for supporting the wheel, and has indexing capability to advance the wheel by a predetermined amount. The device can be used to remove one or more blades from the wheel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] There follows a detailed description of embodiments of the invention by way of example only with reference to the accompanying drawings, in which:

FIG. 1 illustrates a perspective illustration of a sound-reducing enclosure used to house the apparatus used to remove a blade, according to one aspect of the present invention;

FIG. 2 illustrates a perspective illustration of the apparatus, contained within the enclosure of FIG. 1, used to remove a blade, according to one aspect of the present invention; and

FIG. 3 illustrates a perspective illustration of a portion of a compressor wheel positioned to have a blade removed, according to one aspect of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0009] The following embodiments of the present invention have many advantages, including providing an apparatus and method to quickly and safely remove compressor blades, and to reduce the need for serious physical effort by maintenance personnel. In addition, the present invention also reduces the environmental noise in the workplace during a blade removal operation.

[0010] FIG. 1 illustrates one embodiment of the present invention and shows a substantially sound proof enclosure 100 that contains a blade removal apparatus. The doors 110 may be opened to gain access to the interior of enclosure 100, and are preferably sized to permit passage of a compressor wheel. The sound proof enclosure 100 limits and reduces the ambient noise outside the enclosure to under about 80 dbA. Any suitable noise reducing materials or insulating layers can be used to construct the enclosure 100. The enclosure 100 can also incorporate a safety interlock to prevent operation with the door open.

[0011] FIG. 2 illustrates a view of one embodiment of the apparatus used to remove blades of a compressor wheel though the open doors 110 of enclosure 100. The apparatus 200 has a variably indexable turntable 210 that can receive and support a compressor wheel 215.

Not all compressor wheels have the same number of blades so the rotation of turntable 210 can be adjusted to index by the correct angle to advance one blade at a time. The indexing mechanism can be digitally controlled and adjusted.

[0012] The apparatus 200 also comprises a device, such as a hammer 220, for example, a pneumatic hammer (hereinafter referred to as a "hammer" which is not intended to limit the invention in any manner) that may use an air-cooled hardened bit to bear on the blade during removal. The air cooling can help to reduce the temperature of the workpiece and the tool during use. The hammer 220 can be advanced by a hydraulic device that advances the hammer as the blade is removed, thus keeping constant pressure on the blade. The hammer 220 can be rotated in two or more planes and advanced or retracted relative to the blade being removed. This enables the apparatus 200 to be used for a wide variety of blade and wheel sizes.

[0013] Means for communicating power to the hammer 220 may be provided in multiple ways. The hammer 220 may be powered by high-pressure gas through a gas flow path. The high-pressure gas may be supplied by umbilical from outside the enclosure. Alternately, hammer 220 may be powered by an electric solenoid supplied by electric power through an umbilical. An alternate power method could also include ultrasonic or subsonic acoustics, or explosive charge. The hammer can also be an impact hammer, pneumatic hammer or hydraulic hammer. A hydraulic ram may also be connected to hammer 220 to assist in the removal process.

[0014] Remote operation of some or all of the apparatus mechanisms can be provided. For example, a control panel on the exterior of enclosure 100 may be provided, and enable the turntable 210 to be indexed remotely from outside the sound-proof enclosure 100. The hammer 220 can also be operated remotely from outside the sound proof enclosure. In alternative embodiments, a processor can be connected to the apparatus 200 via wired or wireless connection, and be used to control some or all of the components of the apparatus 200.

[0015] Fig. 3 illustrates a view of the hammer 220 contacting one of the blades 305 of compressor wheel 215. The hammer can be manipulated to drive blades 305 out of wheel 215 from either above (as shown) or below.

[0016] A method of removing a blade 305 will now be described according to one aspect of the present invention. A compressor wheel having multiple blades can be transported into enclosure 100 and mounted on turntable 210. A clamping mechanism (not shown) can be used to secure the wheel 215 to turntable 210. A lubricant, such as a penetrating lubricant, can be applied to the blade and dovetail joint to assist in the removal process. The apparatus can be programmed with the proper indexing value to advance the wheel one blade at a time.

[0017] The hammer can be positioned either above or below the blade to be removed. The hammer can be positioned by any suitable sensor (e.g., electrical or optical) or by manually sighting through a window of enclosure 100. A series of initial blows from hammer 220, while maintaining substantially continuous contact with the blade, sets the blade in motion, which may be continued by the force of a hydraulic ram. The operation can be continued until the blade is removed from wheel 215. The turntable 210 then shifts the next blade into position and the process can be repeated until all blades are removed.

[0018] A single head apparatus has been described, but it is to be understood that a multiple head apparatus (e.g., an apparatus having two or more hammers) can be employed. In addition, any blade or airfoil in a compressor or turbine wheel may be removed or installed with the apparatus and method of the present invention.

[0019] Additionally, means (not shown in the Figures) may be provided for dispensing a penetrating lubricant, if so desired, to assist in freeing the blade from the dovetail. Such a penetrating lubricant could be provided from an outside source via umbilical and communicated through a nozzle.

[0020] While various embodiments are described herein, it will be appreciated from the specification that various combinations of elements, variations or improvements therein may be made, and are within the scope of the invention.

Claims

1. An apparatus (200) adapted for removing a blade (305) from a dovetailed slot in a wheel (215) of a rotating machine comprising:

   at least one device (220) adapted to apply a pushing force on a first surface of a blade;
   a turntable (210) for supporting said wheel, said turntable having indexing capability to advance said wheel by a predetermined amount;

   wherein, said at least one device can be used to remove one or more blades from said wheel.

2. The apparatus according to Claim 1, wherein the at least one device comprises at least one of:

   an impact hammer, a pneumatic hammer, and a hydraulic hammer.

3. The apparatus according to Claim 1 or 2, wherein the apparatus is contained within a sound reducing enclosure (100).

4. The apparatus according to Claim 3, wherein the apparatus further comprises:

   a control panel located externally to said sound reducing enclosure.

5. The apparatus according to Claim 3 or 4, wherein the sound reducing enclosure reduces ambient noise outside said enclosure to under at least about 80 dbA.

6. The apparatus according to any of the preceding Claims, wherein the apparatus further comprises:

a hydraulic ram connected to said at least one device, said hydraulic ram used to assist in removal.

7. The apparatus according to Claim 6, wherein the at least one device comprises at least one of:

an impact hammer, a pneumatic hammer, and a hydraulic hammer.

8. The apparatus according to any of the preceding Claims, wherein the machine is at least one of:

a compressor wheel and a turbine wheel.

9. A method for removing a blade from a dovetailed slot in a wheel of a rotating machine comprising:

providing at least one device adapted to apply a pushing force on a first surface of a blade;
providing a turntable for supporting said wheel, said turntable having indexing capability to advance said wheel by a predetermined amount;

wherein, said at least one device can be used to remove one or more blades from said wheel.

10. A method according to Claim 9, further comprising:

mounting said wheel on said turntable.

11. A method according to Claim 9 or 10, further comprising:

activating said at least one device to push said blade out of said dovetailed slot.

12. A method according to Claim 11, further comprising:

activating said turntable to advance said wheel by at least one blade, so that said at least one device may be positioned to remove another blade.

13. A method according to any of Claims 9 to 11, further comprising:

applying lubricant to at least a portion of said blade and at least a portion of said dovetailed slot to assist in removal.

14. A method according to any of Claims 9 to 13, further comprising the step of electing said rotating machine from, at least one of:

a compressor wheel and a turbine wheel.

15. A method according to any of Claims 9 to 14, wherein said providing at least one device step further comprises the step of:

selecting said at least one device from at least one of, a hammer, an impact hammer, a pneumatic hammer, and a hydraulic hammer.

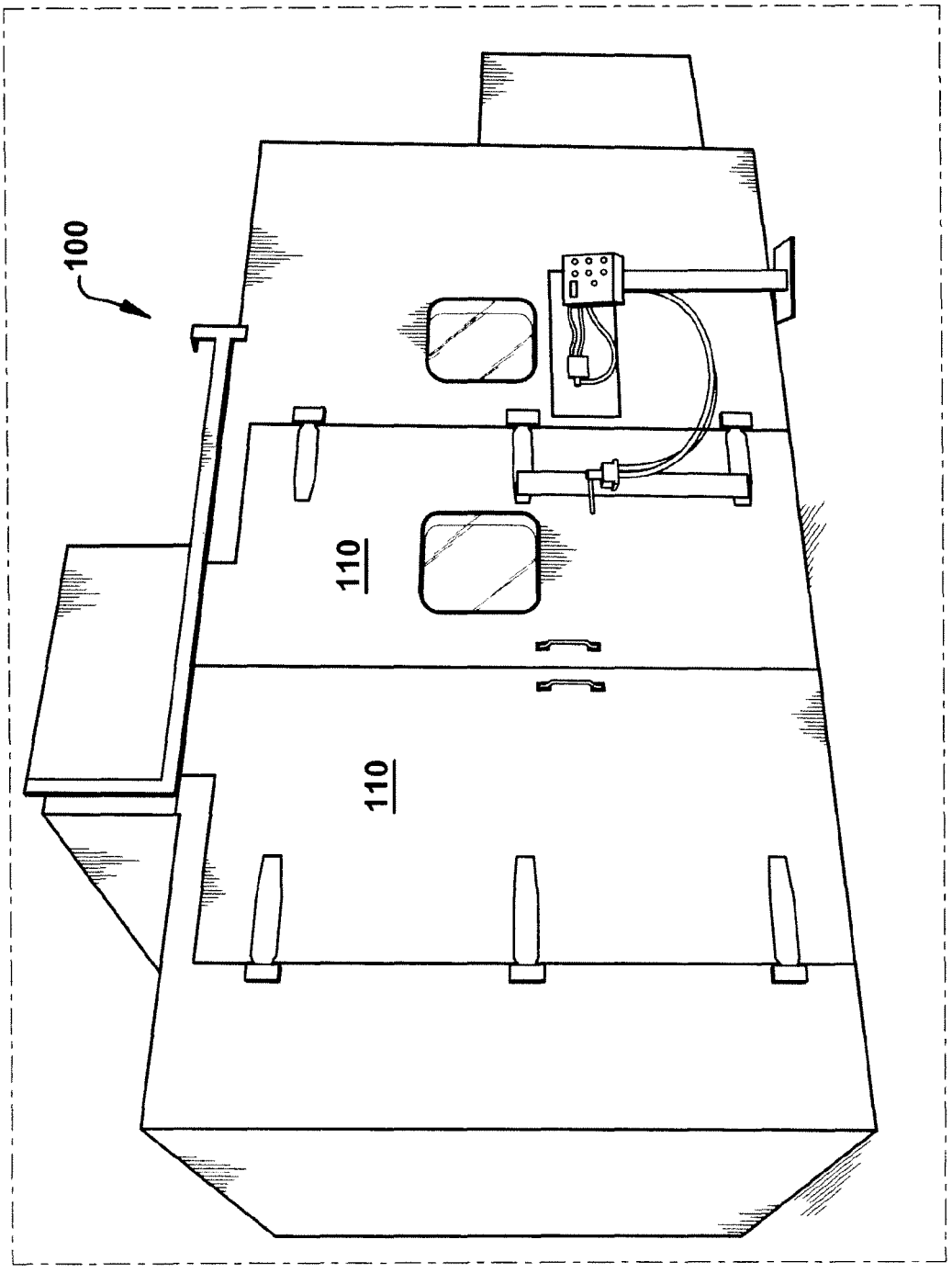


Fig.1

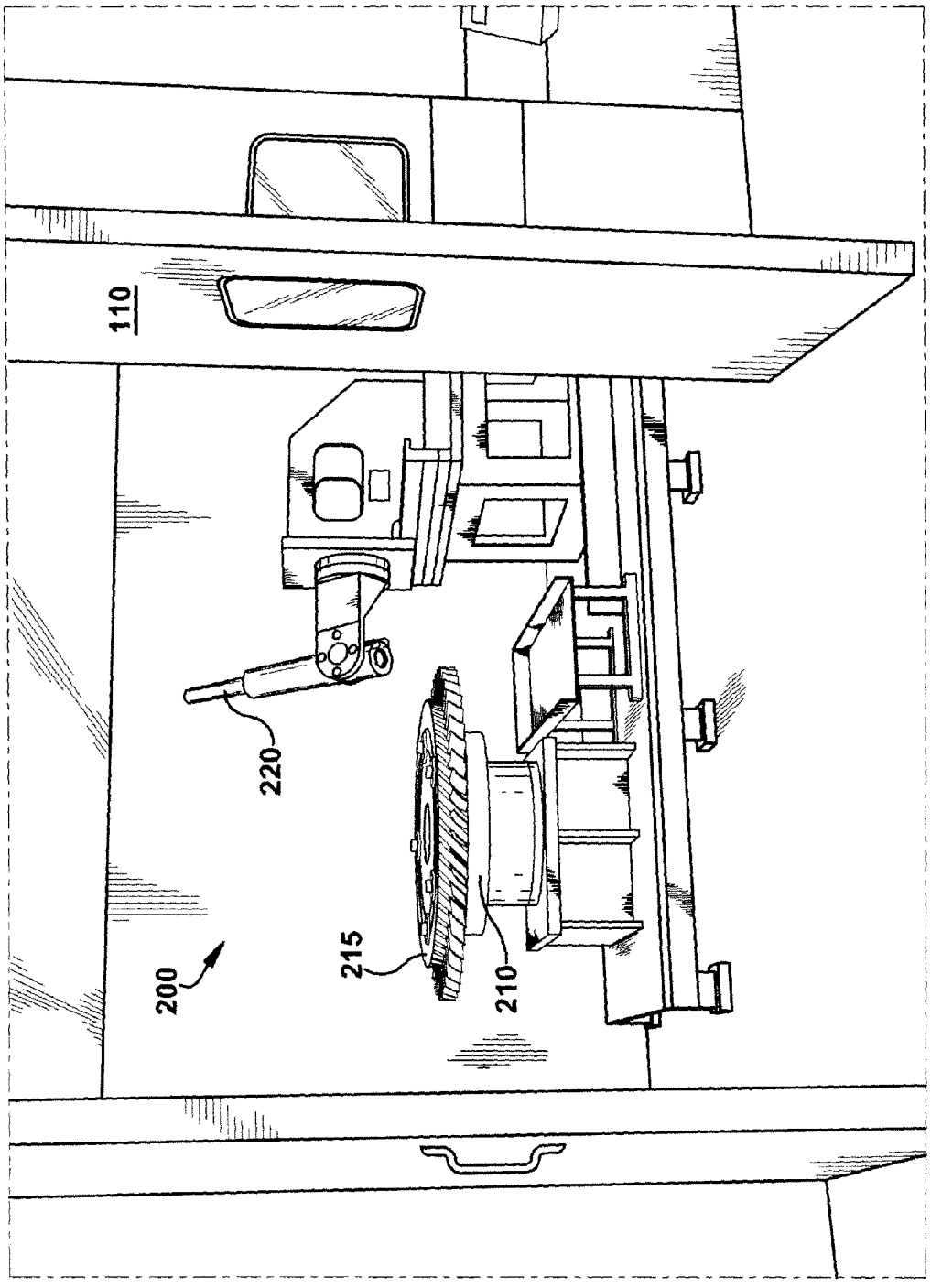


Fig.2

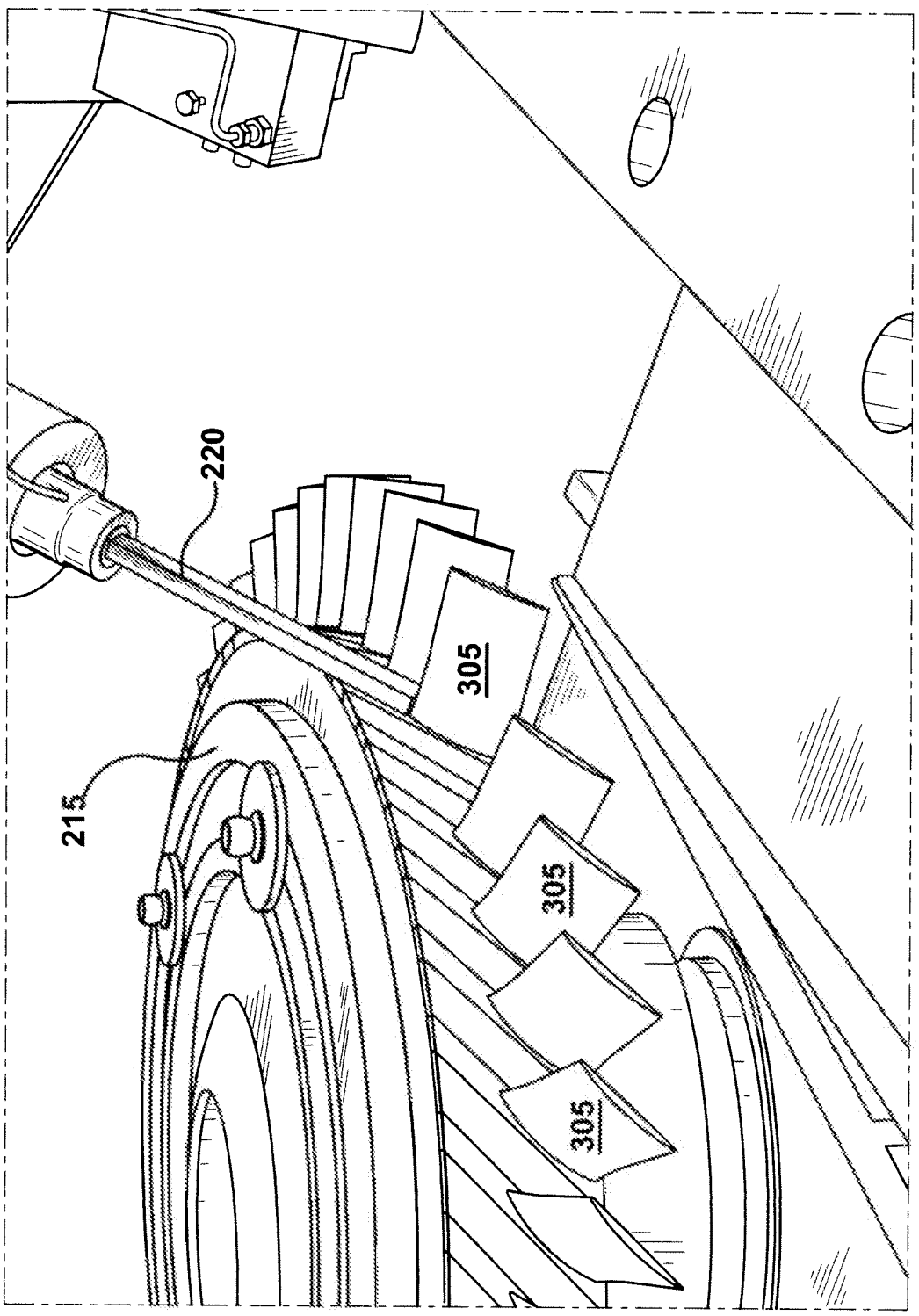


Fig.3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 17 9057

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 1 955 805 A1 (UNITED TECHNOLOGIES CORP [US]) 13 August 2008 (2008-08-13) * abstract * * paragraphs [0008], [0011], [0012], [0016], [0018]; figures *	1-15	INV. F01D25/28 F01D5/00
Y	DD 211 227 A3 (ELBE KRAFTWERKE VEB [DD]) 4 July 1984 (1984-07-04) * abstract * * page 2, paragraph 2 - paragraph 3 * * page 4, line 1 - line 16 * * page 5, line 2 - line 15 * * figures *	1,2,6-15	
A	US 4 455 730 A (GUENTHER PAUL [US]) 26 June 1984 (1984-06-26) * abstract * * column 1, line 5 - line 20 * * column 2, line 1 - line 18 * * figures *	1-15	
A	DE 44 09 686 A1 (BOS BERLIN OBERSPREE SONDERMAS [DE]) 21 September 1995 (1995-09-21) * abstract * * column 1, line 60 - column 2, line 9 * * column 3, line 19 - line 37 * * column 4, line 11 - line 45 * * figures *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F01D

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 June 2010	Mielimonka, Ingo

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

1

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 17 9057

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 3 965 948 A (LUNDIN TORGNY FOLKE VILHELM) 29 June 1976 (1976-06-29) * abstract * * column 1, line 17 - line 18 * * column 1, line 48 - line 60 * * column 3, line 16 - line 24 * * column 3, line 59 - column 4, line 5 * * column 4, line 39 - line 41 * * figures 1,2,5 * -----	3-5	
A	US 2002/085917 A1 (ROBERTS DENNIS WILLIAM [US] ET AL) 4 July 2002 (2002-07-04) * abstract * * paragraphs [0030], [0031] * * figures 3,4 * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 June 2010	Mielimonka, Ingo

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 17 9057

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

02-06-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1955805 A1	13-08-2008	US 2008193293 A1	14-08-2008
DD 211227 A3	04-07-1984	NONE	
US 4455730 A	26-06-1984	CA 1214924 A1	09-12-1986
		JP 1467431 C	30-11-1988
		JP 59051197 A	24-03-1984
		JP 63016600 B	09-04-1988
DE 4409686 A1	21-09-1995	NONE	
US 3965948 A	29-06-1976	DE 2451785 A1	15-05-1975
		FR 2249740 A1	30-05-1975
		GB 1453777 A	27-10-1976
		SE 390130 B	06-12-1976
		SE 7315102 A	09-05-1975
US 2002085917 A1	04-07-2002	EP 1348066 A1	01-10-2003
		JP 3814581 B2	30-08-2006
		JP 2004517245 T	10-06-2004
		WO 02053875 A1	11-07-2002

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82